```
/*
TinyTrackGPS.cpp - A simple track GPS to SD card logger.
TinyTrackGPS v0.12

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*/

/*****************************************************************************
/  Programa de localizacion por gps que graba las posiciones en
/  un fichero de texto cada segundo, de forma diaria.
/
/  - Conectar módulo SD con pin CS (naranja) en pin 10 arduino.
/
/  Uso de librería TinyGPS.
/   Requiere uso de librería SoftwareSerial, se presupone que disponemos
/   de un dispositivo GPS serie de 9600-bauds conectado en pines 9(rx) y 8(tx).
/  - Conectar módulo NMEA-6M (gps) pines 8,9 (9 - pin rx negro)
/
/  - Conectar LCD 16x2 pines 2,3,4,5,6,7 (2-amarillo , 3-azul,
/     4-rojo, 5-azul oscuro, 6-verde, 7-blanco)
/
/  - Conectar OLED 0.96" en SDA y SCL. pines A4 y A5 del Arduino UNO.
*****************************************************************************/
// Include libraries.
#include <Arduino.h>
#include "config.h"
#include "Display.h"
//#include <SoftwareSerial.h>
#include "TinyGPS_GLONASS_fixed.h"
#if defined(__LGT8F__)
#include <LowPower.h>
#endif
#include "SdFat.h"
#include "Vcc.h"
#include <sdios.h>
#include <UTMConversion.h>
#include <Timezone.h>

// Definimos el Display
#if defined(DISPLAY_TYPE_LCD_16X2)
Display LCD(LCD_16X2);
```

```
#elif defined(DISPLAY_TYPE_LCD_16X2_I2C)
Display LCD(LCD_16X2_I2C);
#elif defined(DISPLAY_TYPE_SDD1306_128X64)
Display LCD(SDD1306_128X64);
#elif defined(DISPLAY_TYPE_SDD1306_128X64_lcdgfx)
Display LCD(SDD1306_128X64);
#else
#define NO_DISPLAY
#include <LowPower.h>
#endif

// Variables para grabar en SD.
char GPSLogFile[] = "YYYYMMDD.csv"; // Formato de nombre de fichero. YYYY-Año, MM-Mes, DD-Día.

#if defined(__LGT8F__) || defined(__AVR_ATMEGA328P__)
// Chip select may be constant or RAM variable.
const uint8_t SD_CS_PIN = 10;
//
// Pin numbers in templates must be constants.
const uint8_t SOFT_MISO_PIN = 12;
const uint8_t SOFT_MOSI_PIN = 11;
const uint8_t SOFT_SCK_PIN  = 13;

// SdFat software SPI template
SoftSpiDriver<SOFT_MISO_PIN, SOFT_MOSI_PIN, SOFT_SCK_PIN> softSpi;
// Speed argument is ignored for software SPI.
#if ENABLE_DEDICATED_SPI
#define SD_CONFIG SdSpiConfig(SD_CS_PIN, DEDICATED_SPI, SD_SCK_MHZ(0), &softSpi)
#else  // ENABLE_DEDICATED_SPI
#define SD_CONFIG SdSpiConfig(SD_CS_PIN, SHARED_SPI, SD_SCK_MHZ(0), &softSpi)
#endif  // ENABLE_DEDICATED_SPI
#else
const uint8_t CHIP_SELECT = SS;  // SD card chip select pin. (10)
#endif

SdFat card;   //SdFat.h library.
File file;
bool SDReady;
bool SaveOK;

// Variables y clases para obtener datos del GPS y conversion UTM.
TinyGPS gps;
GPS_UTM utm;
//SoftwareSerial gps_serial(9, 8);
#define gps_serial Serial
int year_gps;
byte month_gps, day_gps, hour_gps, minute_gps, second_gps;
float flat, flon;
unsigned long age;
unsigned int elev;

// Central European Time (Frankfurt, Paris) See below for other zone.
TimeChangeRule CEST = {"CEST", Last, Sun, Mar, 2, 120};     // Central European Summer Time
TimeChangeRule CET = {"CET ", Last, Sun, Oct, 3, 60};       // Central European Standard Time
Timezone CE(CEST, CET);
#define TimeZone CE

```

```
// Variables para gestionar el tiempo local.
TimeElements time_gps;
time_t utctime;
time_t localtime;
time_t prevtime;

/*
--------------------------------------------------------------------------------
 * Info for timezone:

// Australia Eastern Time Zone (Sydney, Melbourne)
TimeChangeRule aEDT = {"AEDT", First, Sun, Oct, 2, 660};    // UTC + 11 hours
TimeChangeRule aEST = {"AEST", First, Sun, Apr, 3, 600};    // UTC + 10 hours
Timezone ausET(aEDT, aEST);
#define TimeZone ausET

// Moscow Standard Time (MSK, does not observe DST)
TimeChangeRule msk = {"MSK", Last, Sun, Mar, 1, 180};
Timezone tzMSK(msk);
#define TimeZone tzMSK

// Central European Time (Frankfurt, Paris)
TimeChangeRule CEST = {"CEST", Last, Sun, Mar, 2, 120};     // Central European
Summer Time
TimeChangeRule CET = {"CET ", Last, Sun, Oct, 3, 60};       // Central European
Standard Time
Timezone CE(CEST, CET);
#define TimeZone CE

// United Kingdom (London, Belfast)
TimeChangeRule BST = {"BST", Last, Sun, Mar, 1, 60};        // British Summer Time
TimeChangeRule GMT = {"GMT", Last, Sun, Oct, 2, 0};         // Standard Time
Timezone UK(BST, GMT);
#define TimeZone UK

// UTC
TimeChangeRule utcRule = {"UTC", Last, Sun, Mar, 1, 0};     // UTC
Timezone UTC(utcRule);
#define TimeZone UTC

// US Eastern Time Zone (New York, Detroit)
TimeChangeRule usEDT = {"EDT", Second, Sun, Mar, 2, -240};  // Eastern Daylight Time
= UTC - 4 hours
TimeChangeRule usEST = {"EST", First, Sun, Nov, 2, -300};   // Eastern Standard Time
= UTC - 5 hours
Timezone usET(usEDT, usEST);
#define TimeZone usET

// US Central Time Zone (Chicago, Houston)
TimeChangeRule usCDT = {"CDT", Second, Sun, Mar, 2, -300};
TimeChangeRule usCST = {"CST", First, Sun, Nov, 2, -360};
Timezone usCT(usCDT, usCST);
#define TimeZone usCT

// US Mountain Time Zone (Denver, Salt Lake City)
TimeChangeRule usMDT = {"MDT", Second, Sun, Mar, 2, -360};
TimeChangeRule usMST = {"MST", First, Sun, Nov, 2, -420};
Timezone usMT(usMDT, usMST);
#define TimeZone usMT
```

```
172
173 // Arizona is US Mountain Time Zone but does not use DST
174 Timezone usAZ(usMST);
175 #define TimeZone usAZ
176
177 // US Pacific Time Zone (Las Vegas, Los Angeles)
178 TimeChangeRule usPDT = {"PDT", Second, Sun, Mar, 2, -420};
179 TimeChangeRule usPST = {"PST", First, Sun, Nov, 2, -480};
180 Timezone usPT(usPDT, usPST);
181 #define TimeZone usPT
182 ------------------------------------------------------------------------------
    ----
183 */
184
185 //------------------------------------------------------------------------------
186 /*
187  * User provided date time callback function.
188  * See SdFile::dateTimeCallback() for usage.
189  */
190 void dateTime(uint16_t* date, uint16_t* time) {
191   // User gets date and time from GPS or real-time
192   // clock in real callback function
193
194   // return date using FAT_DATE macro to format fields
195   //*date = FAT_DATE(year, month, day);
196   *date = (year(localtime)-1980) << 9 | month(localtime) << 5 | day(localtime);
197
198   // return time using FAT_TIME macro to format fields
199   //*time = FAT_TIME(hour, minute, second);
200   *time = hour(localtime) << 11 | minute(localtime) << 5 | second(localtime) >> 1;
201 }
202 //------------------------------------------------------------------------------
203
204 #ifndef NO_DISPLAY
205 #if defined(DISPLAY_TYPE_LCD_16X2) || defined(DISPLAY_TYPE_LCD_16X2_I2C)
206 bool pinswitch();
207 #endif
208 #endif
209 //void GPSRefresh();
210 #if defined(DISPLAY_TYPE_LCD_16X2) || defined(DISPLAY_TYPE_LCD_16X2_I2C)
211 unsigned long iteration = 0;
212 #endif
213
214 #define BAT_MIN  3.250
215 #define BAT_MAX  4.250
216 #define BAT_MIN_mV  3250
217 #define BAT_MAX_mV  4250
218 #define ALFA_BAT   1.0e2  // 100 / (BAT_MAX - BAT_MIN) -> 0..100%
219 #define BETA_BAT   2.5e1  // ALFA_BAT / 4 -> 0..25
220
221 Vcc vcc(1.0);
222
223 uint8_t charge_level(){
224     float f_charge = (vcc.Read_Volts() * BETA_BAT) - (BAT_MIN * BETA_BAT);
225     int i_charge = (int)f_charge;
226     uint8_t charge = constrain(i_charge, 0, 26);
227     return charge;
228 }
229
230 bool GPSData(TinyGPS &gps, GPS_UTM &utm) {
```

```
231   static char buffer[62];
232   static char line[11];
233   static int index;
234   static bool save = false;
235 
236   if (age != TinyGPS::GPS_INVALID_AGE){
237     index = snprintf(buffer,10, "%02d:%02d:%02d,", hour(localtime),
minute(localtime), second(localtime));
238     dtostrf(flat, 10, 6, line);
239     index += snprintf(buffer+index,12,"%s,",line);
240     dtostrf(flon, 10, 6, line);
241     index += snprintf(buffer+index,12,"%s,",line);
242     index += snprintf(buffer+index,7,"%05u,",elev);
243     index += snprintf(buffer+index,19,"%02d%c %ld %ld", utm.zone(), utm.band(),
utm.X(), utm.Y());
244     //Serial.print(buffer);
245   }
246 
247   sprintf(GPSLogFile, "%04d%02d%02d.csv", year(localtime), month(localtime),
day(localtime));
248 
249   //SdFile::dateTimeCallback(dateTime);
250   FsDateTime::setCallback(dateTime);
251 
252   // Si no existe el fichero lo crea y añade las cabeceras.
253   if (SDReady && !card.exists(GPSLogFile)) {
254     if (file.open(GPSLogFile, O_CREAT | O_APPEND | O_WRITE)) {
255       //Serial.print(F("New GPSLogFile, adding heads..."));
256       file.println(F("Time, Latitude, Longitude, Elevation, UTM Coords (WGS84)"));
257       //Serial.println(F("Done."));
258       file.close();
259       }
260       //else {
261       //Serial.println(F("** Error creating GPSLogFile. **"));
262       //}
263   }
264   if (SDReady && (file.open(GPSLogFile, O_APPEND | O_WRITE))) {
265     //Serial.print(F("Open GPSLogFile to write..."));
266     file.println(buffer);
267     file.close();
268     save = true;
269     //Serial.println(F("Done."));
270   } //else {
271     //Serial.println(F("** Error opening GPSLogFile. **"));
272   //}
273   //} //else Serial.println(F("** GPS signal lost. **"));
274   return (save && SDReady);
275 }
276 
277 #ifndef NO_DISPLAY
278 void ScreenPrint(Display &LCD, TinyGPS &gps, GPS_UTM &utm){
279   bool print_utm = false;
280   bool print_grades = false;
281   static unsigned short sats;
282 
283   sats = gps.satellites();
284   #if defined(DISPLAY_TYPE_SDD1306_128X64) ||
defined(DISPLAY_TYPE_SDD1306_128X64_lcdgfx)
285     print_utm = true;
286     print_grades = true;
```

```
  #endif
  #if defined(DISPLAY_TYPE_LCD_16X2) || defined(DISPLAY_TYPE_LCD_16X2_I2C)
  if (!pinswitch()) print_utm = true;
  else print_grades = true;
  #endif

  if (print_utm) {
    static char line[12];
    #if defined(DISPLAY_TYPE_SDD1306_128X64_lcdgfx)
    sprintf(line, "%02d%c?%ld?", utm.zone(), utm.band(), utm.X());
    #else
    sprintf(line, "%02d%c %ld ", utm.zone(), utm.band(), utm.X());
    #endif
    //Serial.println(line);
    LCD.print(0,0,line);
    LCD.print_PChar((byte)6);
    #if defined(DISPLAY_TYPE_SDD1306_128X64_lcdgfx)
    sprintf(line, "%02hu?", sats);
    #else
    sprintf(line, "%02hu ", sats);
    #endif
    //Serial.println(line);
    LCD.print(12,0,line);
    (SaveOK) ? LCD.print_PChar((byte)7) : LCD.print("-");

    // New line
    #if defined(DISPLAY_TYPE_SDD1306_128X64_lcdgfx)
    sprintf(line, "%ld?", utm.Y());
    #else
    sprintf(line, "%ld ", utm.Y());
    #endif
    //Serial.println(line);
    LCD.print(1,1,line);
    LCD.print_PChar((byte)5);
    #if defined(DISPLAY_TYPE_SDD1306_128X64_lcdgfx)
    sprintf(line, "%u@", elev);
    #else
    sprintf(line, "%um", elev);
    #endif
    //Serial.println(line);

    unsigned int elev_n = elev;
    byte n = 1;
    while (elev_n > 9){
      elev_n /= 10;
      n++;
    }
    LCD.print(15-n,1,line);

    /*
    if (elev < 10) LCD.print(14,1,line);
    else if (elev < 100) LCD.print(13,1,line);
    else if (elev < 1000) LCD.print(12,1,line);
    else LCD.print(11,1,line);
    */
  }

  if (print_grades) {
    static char line[11];
    LCD.print(0,(LCD.display_type() == SDD1306_128X64) ? 2 : 0,"LAT/");
```

```
    dtostrf(flat, 8, 6, line);
    LCD.print(line);

    LCD.print(0,(LCD.display_type() == SDD1306_128X64) ? 3 : 1,"LON/");
    dtostrf(flon, 8, 6, line);
    LCD.print(line);
  }
}

#if defined(DISPLAY_TYPE_LCD_16X2) || defined(DISPLAY_TYPE_LCD_16X2_I2C)
bool pinswitch() {
  bool pin;

  pin = bitRead(iteration,4); // Change every 8 seconds.
  //LCD.clr(); -> Too slow clear individual characters.
  if ((iteration%16) == 0) {
    LCD.print(15,0," ");
    LCD.print(15,1," ");
  } else LCD.print(0,1," ");
  return pin;
}
#endif
#endif
/*
void GPSRefresh()
{
    while (gps_serial.available() > 0)
      gps.encode(gps_serial.read());
}
*/
/*
time_t makeTime_elements(int year, byte month, byte day, byte hour, byte minute,
byte second){
  static TimeElements tm;

  tm.Year = year - 1970;
  tm.Month = month;
  tm.Day = day;
  tm.Hour = hour;
  tm.Minute = minute;
  tm.Second = second;

  return makeTime(tm);
}
*/

void setup(void) {
  #if defined(__LGT8F__)
  ECCR = 0x80;
  ECCR = 0x00;
  #endif
  delay(100);
  //Serial.begin(9600);
  gps_serial.begin(9600);

  //Serial.print(F("Initializing SD card..."));

  #if defined(__LGT8F__)
  SDReady = false; //SDReady = card.begin(SD_CONFIG);
  #else
```

```
  SDReady = card.begin(SS);
  #endif
  //(SDReady) ? Serial.println(F("Done.")) : Serial.println(F("FAILED!"));

  /* Iniciaización del display LCD u OLED */
  #ifndef NO_DISPLAY
  LCD.start();
  #endif

  //Serial.print(F("Waiting for GPS signal..."));
  #ifndef NO_DISPLAY
  //LCD.clr();
  #if defined(DISPLAY_TYPE_LCD_16X2) || defined(DISPLAY_TYPE_LCD_16X2_I2C) ||
defined(DISPLAY_TYPE_SDD1306_128X64)
  LCD.print(NAME, VERSION, "Waiting for ","GPS signal...");
  #elif defined(DISPLAY_TYPE_SDD1306_128X64_lcdgfx)
  #if defined(__LGT8F__)
  LCD.DrawLogo();
  #else
  LCD.print(NAME_M, VERSION);
  #endif
  #endif
  unsigned int time = 0;
  #endif

  bool config = false;

  do {
    #ifndef NO_DISPLAY
    LCD.wait_anin(time++);
    LCD.drawbattery(charge_level());
    #endif
    for (unsigned long start = millis(); millis() - start < 1000;) {
      while (gps_serial.available() > 0) {
        char c = gps_serial.read();
        //Serial.write(c); // uncomment this line if you want to see the GPS data
flowing
        if (gps.encode(c)) {// Did a new valid sentence come in?
          gps.crack_datetime(&year_gps, &month_gps, &day_gps, &hour_gps,
&minute_gps, &second_gps, NULL, &age);
          (age != TinyGPS::GPS_INVALID_AGE) ? config = true : config = false;
        }
      }
    }
  }while(!config);

  time_gps.Year = year_gps - 1970;
  time_gps.Month = month_gps;
  time_gps.Day = day_gps;
  time_gps.Hour = hour_gps;
  time_gps.Minute = minute_gps;
  time_gps.Second = second_gps;
  utctime = makeTime(time_gps);
  localtime = TimeZone.toLocal(utctime);
  prevtime = utctime;
  //Serial.println(F("Done."));
  //Serial.println(F("Configuration ended."));
  #ifndef NO_DISPLAY
  LCD.clr();
  #endif
```

```
}

void loop(void) {
  bool gps_ok = false;
  uint8_t charge;

  while (gps_serial.available() > 0) {
    char c = gps_serial.read();
    //Serial.write(c); // uncomment this line if you want to see the GPS data flowing
    if (gps.encode(c)) {
      gps.crack_datetime(&year_gps, &month_gps, &day_gps, &hour_gps, &minute_gps, &second_gps, NULL, &age);
      (age != TinyGPS::GPS_INVALID_AGE) ? gps_ok = true : gps_ok = false;
    }
  }

  gps.f_get_position(&flat, &flon, &age);
  if ((elev = gps.altitude()) == TinyGPS::GPS_INVALID_ALTITUDE) elev = 0;
  else elev /= 100L;
  utm.UTM(flat, flon);

  time_gps.Year = year_gps - 1970;
  time_gps.Month = month_gps;
  time_gps.Day = day_gps;
  time_gps.Hour = hour_gps;
  time_gps.Minute = minute_gps;
  time_gps.Second = second_gps;
  utctime = makeTime(time_gps);
  localtime = TimeZone.toLocal(utctime);

  charge = charge_level();

  #if defined(__LGT8F__)
  (!card.sdErrorCode()) ? SDReady = true : SDReady = card.begin(SD_CONFIG);
  #endif

  if (gps_ok && (charge>0)) {
    if (utctime > prevtime) {
      SaveOK = GPSData(gps, utm);
      prevtime = utctime;
      #if defined(DISPLAY_TYPE_LCD_16X2) || defined(DISPLAY_TYPE_LCD_16X2_I2C)
      iteration++;
      #endif
    }
    #ifndef NO_DISPLAY
    ScreenPrint(LCD, gps, utm);
  } else if (charge==0){
      LCD.clr();
    #endif
  }
  #ifndef NO_DISPLAY
  LCD.drawbattery(charge);
  #endif

  #if defined(__LGT8F__)
  LowPower.idle(SLEEP_120MS, ADC_ON, TIMER2_OFF, TIMER1_OFF, TIMER0_OFF, SPI_ON, USART0_ON, TWI_ON);
  if(!SDReady) card.end();
  #endif
```

```
520
521   #ifdef NO_DISPLAY
522   LowPower.powerSave(SLEEP_250MS, ADC_OFF, BOD_ON,TIMER2_OFF); // para NO_DISPLAY.
523   #endif
524
525   //LCD.clr();
526 }
527
```